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ORDBG-1327--24 Oct 51

MARYLAND

DETERMINATION OF THE PENETRATING CAPABILITIES OF

SHOT, AF, 120MM, T116E6, WITH

A SOLID CONICAL NOSE DESIGN (U)

THIS DOCUMENT CONSISTS OF 14 PAGES

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DEVELOPMENT AND PROOF SERVICES

Report OCO Project No. 190

Regrading data cannot be predetermined. ABERDEEN PROVING GROUND, MD--415

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DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

AUTHORITY: ORDBA-MDR
File APG 471.1/126

R. Dempsey/tsp

DETERMINATION OF THE PENETRATING CAPABILITIES OF
SHOT, AP, 120 MM, T116E6, WITH
A SOLID CONICAL NOSE DESIGN (U)
APG MISCELLANEOUS REPORT NUMBER 170
DATES OF TEST: 1st and 2nd October 1957

ABSTRACT

To determine the penetrating capability of 120 mm AP shot with a solid conical nose design and compare it with the standard 120 mm AP shot.

All rounds were fired against Plate, Armor, class B, Rolled Homogeneous, 5" x 120" x 144", average BHN 276, charpy (-40°F) 44 ft lbs, at 55° obliquity.

Velocities (striking) were obtained in the establishment of PEL.

The penetrating capabilities of the test shot are considered inferior to the standard 120 mm AP shot.

The maximum range at which the test shot are effective against five-inch plate at 55° obliquity is considered to be approximately 260 yards when firing from a tube having only two proof rounds fired previously.

It is recommended that Shot, AP, 120 mm, Design R-9, Drawing Number FF 8494 (solid conical nose design) be considered inferior to the standard 120 mm AP shot.

It is also recommended that further study of the integral windshield concept be conducted.

58 AA

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APR 3 1958

REGRADEING DATA CANNOT BE PREDETERMINED
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I. INTRODUCTION

A. Windshield separation during flight has been experienced in the firings of 120mm, AP, T116 Series Shot. These failures can be attributed to improper obturation (gas "blow-by"), improper cyclewelding techniques and/or an inadequate cycleweld composition necessary to overcome aerodynamic heating. The development and adoption of the obturator assembly eliminated failures caused by improper obturation. To alleviate the problem of improper cyclewelding an impact fixture was designed and incorporated in the shot manufacture insuring a minimum bond strength.

B. In order to eliminate inadequate cyclewelding composition a test was initiated utilizing shot made from a single piece of steel with a solid conical nose design. This would completely eliminate the joint between the windshield and shot body, the initial point of windshield separation, therefore insuring windshield retention.

II. DESCRIPTION OF MATERIAL

Ten each Shot, AP, 120mm, Design R-9, Drawing Number FF-8494, Lot FA-E-139, were submitted for test. This shot is designed with an integral steel windshield. The entire round except for the standard double class B gilding metal rotating bands was made from a single piece of steel. A parabolic-shaped hole designed to prevent excessive stress concentration at impact was bored into the base of the shot to maintain the prescribed 50-pound projectile weight. The different Rockwell hardness of the shot can be found in Appendix B (Drawing No. FF-8494).

III. DETAILS OF TEST

A. PROCEDURE

1. The essential number of rounds were fired at five-inch armor plate at 55° obliquity (BHN-276; charpy at -400F, 44ft-lbs) to determine a protection ballistic limit for the test design (solid conical nose) and the standard shot (ogival nose with windshield).

2. Chamber pressures were obtained by placing two M3 Gages in the base of each

3. Projectile transit time through two solenoid coils was recorded and striking velocities were calculated on all rounds.

4. Yaw cards were placed on both velocity coils and in front of the plate in order to determine the stability of the shot.

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B. RESULTS

1. Data obtained in establishment of PBL.

a. Test shot (solid conical nose design)

| <u>TUBE RD NO.</u> | <u>STRIKING VELOCITY (fps)</u> | <u>CHAMBER PRESSURE psi/100</u> | <u>PARTIAL OR COMPLETE PENETRATION</u> |
|----------------------------|--|---|--|
| 94 | 3452 | 528 | C |
| 95 | 3408 | 494 | P |
| 96 | 3445 | 528 | C |
| 97 | 3443 | 511 | P |
| 104 | 3421 | 504 | P |
| 106 | 3444 | 536 | C |
| PBL - 3436 fps | | | |

b. Standard shot (ogival nose with windshield)

| <u>TUBE RD NO.</u> | <u>STRIKING VELOCITY (fps)</u> | <u>CHAMBER PRESSURE psi/100</u> | <u>PARTIAL OR COMPLETE PENETRATION</u> |
|----------------------------|--|---|--|
| 99 | 3008 | 365 | C |
| 100 | 2903 | 330 | P |
| 103 | 3000 | 334 | C |
| 105 | 2935 | 330 | P |
| 107 | 2956 | 343 | P |
| 108 | 2970 | 354 | C |
| PBL - 2962 fps | | | |

2. No yawing of the shot was observed on the three yaw cards.

3. All striking impressions on the plate were of the same essential shape, indicating that the break-up and rolling of the shot were essentially the same.

4. Measurements of the complete penetrations on the back of the plate were greater (8" x 10-1/2") for the test shot than those for the standard shot (6" x 6-1/4").

5. Complete round-by-round data can be found in Appendix A of this report.

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IV. CONCLUSIONS

- A. The penetrating capabilities of the test shot are considered inferior to the standard 120mm AP shot.
- B. The maximum range at which the test shot are effective against 5-inch plate at 55° obliquity is considered to be approximately 260 yards when firing from a tube having only two proof rounds fired previously.

V. RECOMMENDATIONS

It is recommended that:

1. Shot, AP, 120mm, Design R-9 (solid conical nose design) be considered inferior to the standard 120mm AP shot.
2. Further study of the integral windshield concept be conducted. The following approaches are suggested.
 - a. The shot be designed with an integral windshield and solid body construction. Weight is maintained constantly by shortening the body cylinder.
 - b. In the event suggestion 'a' results in a shot with too short a body cylinder, an alternate design using a base cavity be considered. Firings of the T116 Shot in October 1953 indicated satisfactory penetration with a base cavity 1-1/4 inches in diameter and 3-1/8 inches deep.
 - c. A shot be designed similar to Design R-9 with the cavity eliminated. This would result in a weight increase of approximately 9-1/2 pounds. This might reduce the Ballistic Limit but would have the disadvantage of requiring the reassessment of the propelling charge.

SUBMITTED:

Robert N. Dempsey
ROBERT N. DEMPSEY
Project Engineer

REVIEWED:

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E. B. ANDERSON
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Chief, Artillery Div.

APPROVED:

H. A. Noble
H. A. NOBLE
Assistant to the Deputy Director for
Engineering Testing
Development and Proof Services

REFERENCES

Test Program Request #FA-MDR-476
Frankford Arsenal, Philadelphia, Pennsylvania

OBSERVERS

Pvt. D. E. Davison
Mr. W. Blittersdorf
Mr. B. Bushey

Frankford Arsenal
Frankford Arsenal
Frankford Arsenal

APPENDICES

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APPENDIX A

ORDNANCE CORPS
FRANKFORD ARSENAL
PHILADELPHIA 37,
PENNSYLVANIA

DEDavison/mlp/23146

IN REPLY
REFER TO ORDBA-MDR

22 AUG 1957

SUBJECT: 120mm T116, Design R-9

TO: Commanding General
Aberdeen Proving Ground
Aberdeen, Maryland

Attention: D&PS, Mr. G. Youmans

1. Inclosed is Test Program Request #FA-MDR-478 covering testing of Shot, 120mm, T116, Design R-9. It is requested that this Arsenal be notified in advance of the test in order that a representative may be present if so desired.

2. Funds in the amount of \$10,000 have been forwarded to your installation under PESD 70304111-19-48324-00-0 (OAG Project 56-197) to cover the cost of this test and the adhesive firing test.

FOR THE COMMANDER:

2 Incls

1. TPR #FA-MDR-478 (in dup)
2. Dwg. No. FF 8494

Lloyd C. Lang
LLOYD C. LANG
Major, Ord Corps
Assistant

cc: ORDLY-AR-AR, Attn: Mr. H. Holusha
Mr. Blittersdorf, MIR

ordb 471.1/126

TPR #FA-MDR-478
Frankford Arsenal, Phila. 37, Pa.
DDavison/alp/22146

1. Material for Test:

Ten (10) each Shot, AP, 120mm, Design R-9, Drawing Number FF8494, Rev 0

2. Project Authority: Sub-Project No. 70304111-19-48024-01

3. Object of Development or Experiment: The object of this development is to develop a satisfactory Shot, AP, 120mm, T116.

4. History Sketch:

Design R-9 is a 120mm AP Shot designed with an integral steel windshield to eliminate windshield failure. The entire round except for rotating bands is made from a single piece of steel. A hole has been bored into the base of the shot to maintain the prescribed 50 lb. projectile weight. The parabolic shape of the hole is designed to prevent excessive stress concentration at impact. The rotating bands are the standard double Class B gilding metal. The hardness from the nose to the bourrelet is Rockwell C-60. The hardness in the rotating band area is Rockwell C-40. The area between the bourrelet and bands is devoted to a transition zone from Rockwell C-60 to Rockwell C-40.

5. Improvements Made Since Last Proving Ground Test: See History Sketch

6. Local Tests: None

7. Object of Test: The object of this test is to determine the penetrating capability of a solid conical nose design and to compare it with the standard ogival nose shot with windshield.

8. Precautions in Handling and Testing: The usual precautions in handling and testing AP Shot should be followed.

9. Recommended Test Program:

a. Determine Protection Ballistic Limit for Design R-9 against 5" homogeneous armor plate at 55° obliquity.

b. Determine reference PBL for standard T116E6 or T116E7 against the same armor plate at the same obliquity.

c. Place yaw cards at each velocity coil and in front of plate for each test round.

10. References: TT-08120 - from ORDLY-AAR, Col. Worthing to ORDBA-MHC-Ripka

11. Coordination:

Ordnance Ammunition Command
Aberdeen Proving Ground
Frankford Arsenal

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**DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND, MARYLAND
FIRING RECORD**

ATTACHMENT B

OBJECT OF TEST: To Determine the
Penetrating Capability
of 120mm AP shot with
a Solid Conical Nose
Design and Compare it
With the Standard 120mm
AP shot (ogival nose
With Windshield)

DATES OF TEST: 1, 2 October
1957
FIRING RECORD NO: P-62872
SHEET 1 OF 4
AUTHORITY: ORDBG 471.1/126
WORK ORDER NO: 331-810-01

PRODUCTION ENGINEERING

tsp

MATERIAL

Gun, 120mm, TL23E1, No. 126.
Tube, 120mm, TL23E1, No. 4380

AMMUNITION COMPONENTS

TEST:

Shot, AP, 120mm, TL16E6, Design R-9. Lot FA-E-139.

STOCK:

| | |
|---------------------------------------|----------------|
| Shot, AP, 120mm, TL16E6, | Lot ROW 9-3 |
| Case, Cartridge, 120mm, T25, | Lot CHA 10-8. |
| Primer, Percussion, T79, | Lot LS 24-4. |
| Propellant, MP, M17 (0.679 inch web), | Lot RAD-37153. |
| Plug, closing, M2 E2, | Lot STOCK. |

FACILITIES

Fired from 2100-yard range on Main Front.
Recoil Mechanism, 155mm, M3, No. 1676.
Carriage, Gun, Motor, M40, U.S.A. No. 40194662.

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FIRING RECORD NO. P-62878
SHEET 2 OF 4

INSTRUMENTATION

VELOCITY MEASUREMENT:

Velocities were obtained by firing through two solenoid coils placed in front of the gun and recording projectile transit time by counter chronograph. From this measured velocity muzzle and striking velocities were calculated.

COIL DISTANCES:

Gun to 1st coil 90.33 ft.
1st to 2nd coil 51.67 ft.
2nd coil to plate 220.00 ft.

CHAMBER PRESSURE MEASUREMENTS:

Gage, Pressure, Medium Caliber M3 (2 per round)
Copper, Cylinder, Crusher, Metal of 1955, Annealed 1955
Lot 7c-55.

ARMOR PLATE DATA

Class B, Rolled Homogeneous, 5" x 120" x 144", Number 048571
Average BHN 276 Charpy (-40°F) 44 ft-lbs.

Chemical composition, %:

C-0.28; MM-0.30; Si-0.20; S-0.022; P-0.011;
Cr-1.59; Ni-3.29; Mo-0.40

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FIRING RECORD NO. P-62878
SHEET 3 OF 4

ROUND BY ROUND DATA

PENETRATION RESULTS
PARTIAL PENETRATION

| ROUND NUMBER | PROJECTILE | | PROP. | | STRIKING VELOCITY | CHAMB. PRESS. | COMPLETE OR PARTIAL | SIZE OF BULGE ON BACK | | NUMBER & SIZE OF CRACKS | SIZE OF COMPLETE PENETRATIONS |
|--------------|------------|--------|--------|--------|-------------------|---------------|---------------------|-----------------------|----------|-------------------------|-------------------------------|
| | TYPE | WEIGHT | WEIGHT | HEIGHT | | | | INCHES | INCHES | | |
| 90 | Test | 49.58 | 26 | 0 | 3352 | 474 | P | 2-1/2 | 1-4" | 1-3 3/4" | 5-3/4 x 6 |
| 91 | Test | 49.62 | 25 | 0 | 3385 | 458 | P | 1-3/4 | --- | --- | --- |
| 92 | Standard | 49.98 | 24 | 0 | 3188 | 457 | C | --- | --- | --- | --- |
| 93 | Test | 49.58 | 27 | 0 | 3464 | 492 | - | --- | --- | --- | --- |
| 94 | Test | 49.57 | 27 | 0 | 3452 | 528 | C | --- | --- | --- | --- |
| 95 | Test | 49.62 | 26 | 8 | 3408 | 494 | P | 1-3/4 | 1-7 1/8" | --- | 6-1/4 x 6-3/4 |
| 96 | Test | 49.61 | 26 | 12 | 3445 | 528 | C | --- | --- | --- | --- |
| 97 | Test | 49.64 | 26 | 12 | 3443 | 511 | P | 1-1/2" | 1-1/2" | --- | 7 x 5 1/2 |
| 98 | Standard | 50.00 | 23 | 0 | 3101 | 404 | C | --- | --- | --- | --- |
| 99 | Standard | 49.96 | 22 | 0 | 3008 | 365 | C | --- | --- | --- | 5 x 6 |
| 100 | Standard | 50.03 | 21 | 0 | 2903 | 330 | P | --- | --- | --- | 6 x 6-1/4 |
| 101 | Standard | 50.02 | 21 | 4 | 299 | 229 | P | 1 | 0 | --- | --- |
| 102 | Standard | 50.00 | 21 | 8 | 290 | 230 | P | 3/4 | 0 | --- | --- |
| 103 | Standard | 50.03 | 21 | 14 | 3000 | 334 | C | 3/4 | 0 | --- | --- |
| 104 | Test | 49.64 | 26 | 14 | 3421 | 504 | P | --- | --- | --- | 4-7/8 x 5-1/4 |
| 105 | Standard | 50.02 | 21 | 6 | 2935 | 338 | P | 2 | 2-1 | --- | --- |
| 106 | Test | 49.59 | 27 | 1 | 3444 | 536 | P | 1-1/4 | 1-4 | --- | --- |
| 107 | Standard | 50.02 | 21 | 6 | 2956 | 343 | C | --- | --- | --- | 8 x 10-1/2 |
| 108 | Standard | 50.00 | 21 | 12 | 2970 | 354 | C | 2 | 1-3" | --- | 5-1/2 x 6 |

NOTES: 1 - Tube round no. 93 hit top of plate (penetration data disregarded).

2 - Tube round numbers 101 & 102, charge incorrectly weighed.

3 - Tube round numbers considered in PBL of test rounds: 95, 97 and 104

Partial Penetrations: 94, 96 and 106

Complete Penetrations: 94, 96 and 106

Tube round numbers considered in PBL of standard rounds:

Partial Penetrations: 100, 105 and 107

Complete Penetrations: 99, 103 and 108

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FIRING RECORD NO. P-62878
SHEET 4 OF 4

APPROVED:

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H. B. Anderson
H. B. ANDERSON
Chief, Artillery
Ammunition Branch

Robert N. Dempsey
ROBERT N. DEMPSEY
Project Engineer

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APPENDIX D

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